SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

JHRP-75-7

ENGINEERING SOILS MAP OF VANDERBURGH COUNTY, INDIANA

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PURDUE UNIVERSITY

INDIANA STATE HIGHWAY COMMISSION

Final Report

ENGINEERING SOILS MAP OF VANDERBURGH COUNTY, INDIANA

March 26, 1975

TO: J. F. McLaughlin, Director
Joint Highway Research Project

Project: C-36-51B

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 1-5-2-56

The attached report, entitled "Engineering Soils Map of Vanderburgh County, Indiana", completes a portion of the project concerned with development of county engineering soils map of the state of Indiana. This is the 56th report in the series. The report was prepared by Dr. P. T. Yeh, Research Engineer, Joint Highway Research Project.

The soils mapping of Vanderburgh County was done primarily by airphoto interpretation. Test data along US 460, US 41, I-64 and SR 66 are included in the report. Generalized soil profiles of the major soil for each land form are presented on the engineering soils map. An ozalid print of the engineering soils map of Vanderburgh County is included in the report.

Respectfully submitted,

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Final Report

ENGINEERING SOILS MAP OF VANDERBURGH COUNTY

by

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Research Engineer

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Project No.: C-36-51B

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Conducted by

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Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

Purdue University
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The author wishes to acknowledge the assitance given by all those persons who have helped in the preparation of this report. Special acknowledgements are due the members of the Advisory Board, Joint Highway Research Project, for their active interest in furthering the study; Professor H. L. Michael, Associate Director, Joint Highway Research Project for review of the report and Professor R. D. Miles, in charge of the Airphoto Interpretation, and Photogrammetry and Site Selection Laboratory for review and suggestions.

All airphotos used in connection with the preparation of this report automatically carried the following credit line: Photographed for commodity stabilization service, Performance and Aerial Photography Division, United States, Department of Agriculture.

ENGINEERING SOILS MAP

OF

VANDERBURGH COUNTY, INDIANA

INTRODUCTION

The engineering soils map of Vanderburgh County, Indiana which accompanies this report was done primarily by airphoto interpretation. The aerial photographs, having an approximate scale of 1:20,000, were taken in August 1940 for the United States Department of Agriculture and were purchased from that agency.

Aerial photographic interpretation of the land forms and engineering soils of this county was accomplished in accordance with accepted principles of observation and inference (1)*. A two-day field trip was made to the area for the purposes of resolving ambiguous details and correlating aerial photographic patterns with soils texture. Standard symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to delineate land forms and soil textures. The test of this report largely represents an effort to overcome the limitation imposed by adherence to a standard symbolism and map presentation.

Although no soil samples were collected and tested by the staff of the Joint Highway Research Project, general soil profiles were developed and are shown on the soils map. The soil profiles were compiled from the agriculture literature and from

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* Number in parenthesis indicate reference in the bibliography.

the boring data of the roadway survey along I-64, US 41, US 460, and SR 66 supplied by the State Highway Commission. Liberal reference was made to the "Formation Distribution and Engineering Characteristics of Soils" (2), "Soil Survey of Vanderburgh County, Indiana" (3) and "Airphoto Interpretation of Engineering Soils of Interstate Highway Route 64 Between US 41 and Scalesville in Gibson, Vanderburgh and Warrick Counties, Indiana" (4).

DESCRIPTION OF AREA

GENERAL

Vanderburgh County is located in the southwestern part of the state. The county is bounded on the west by Posey County, on the north by Gibson County, on the east by Warrick County and on the south by the Ohio River (Figure 1). The maximum length from north to south is about 23 miles and the maximum width from east to west is about 13 miles. The area of Vanderburgh County is approximately 241 square miles or 154,240 acres (5).

Evansville, situated in the southern part of the county along the Ohio River, is the seat of government. The city had a population of 142,455 while the county held a total number of inhabitants of 168,772 during the 1970 census (6).

According to the 1964 Census of Agriculture 59.9% of Vanderburgh County or 923,898 acres was farm land (5). There were 6,439 acres of wooded land in the county which was generally confined along the bluffs and gullies of rivers and streams as shown

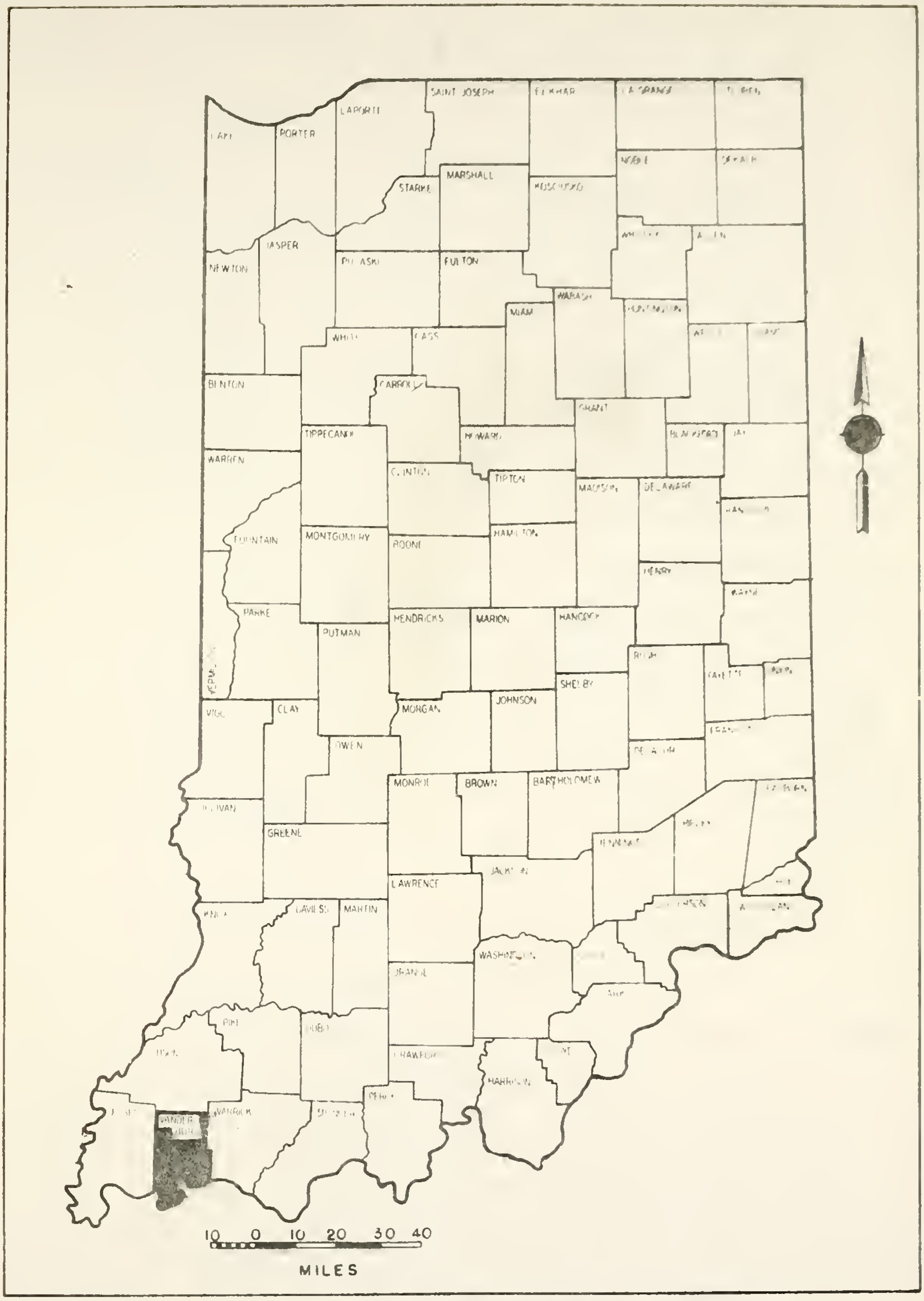


FIG. I LOCATION MAP OF VANDERBURGH COUNTY

in Figure 2.

DRAINAGE FEATURES

Although the northwestern and west-central parts of Vanderburgh County drain westward into the Wabash River, the entire county is included in the Ohio River basin.

In the north and western parts of the county the area is drained by Pond Flat Ditch, Upper Big Creek, Lower Big Creek, Barrs Creek and the South Fork of Big Creek (see Figure 3). These are all tributaries of Big Creek which discharges its water into the Wabash River in Posey County. The eastern and central portions of the county are drained by Blue Grass Creek, Little Pigeon Creek and Locust Creek, which flow into Pigeon Creek and thence into the Ohio at the west end of Evansville. Carpender Creek and Bayou Creek drain the southwestern part of the county and empty their waters into the Ohio River directly within the county.

Pond Flat Ditch, Upper Big Creek and Barrs Creek flow westerly and northwesterly across the old lake plain. The stream has a low gradient and the flow is slow. Many ditches and channels have been dug in these areas to improve the drainage. The lower portions of the Blue Grass Creek, Little Pigeon Creek, Locust Creek and Pigeon Creek flow on lacustrine plain also. Channels are straightened in many places to facilitate the flow of the streams. The headwaters, or the upper portion of the

FIG. 2. AIRPHOTO MOSAIC OF VANDERBURGH COUNTY, INDIANA

FROM 1958 INDEX MAP

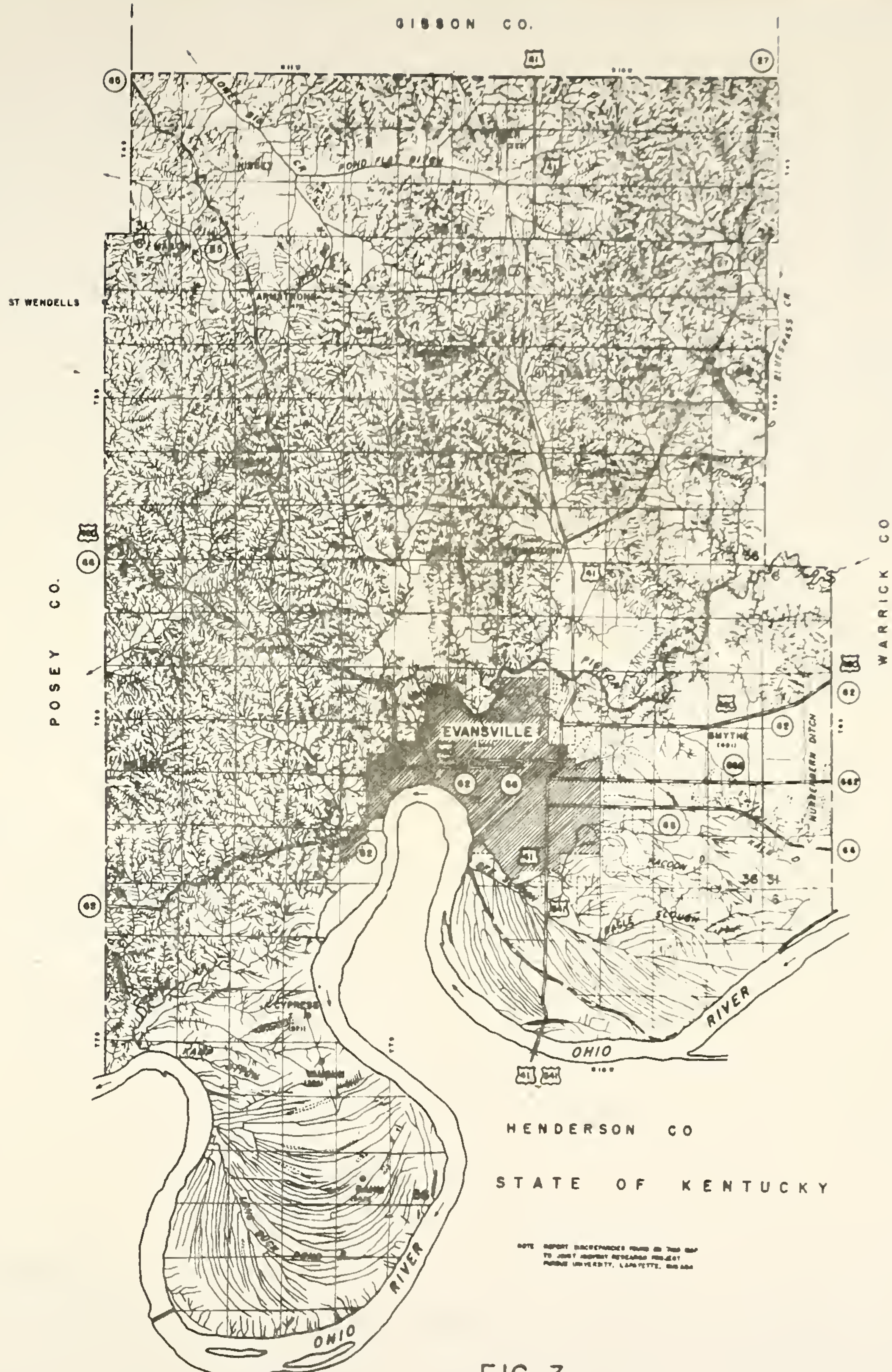


FIG. 3

DRAINAGE MAP

VANDERBURG COUNTY

INDIANA

streams mentioned above, and the other stream systems within Vanderburgh County are highly dissected. Most of the slopes break sharply and slope steeply to the narrow bottoms. These bottoms widen rapidly as they approach the main streams.

Vanderburgh County has a fine textured dendritic drainage pattern except in the lacustrine areas and the Ohio River Flood plains where a man-made ditch systems prevail. Local depressions and a few old current scars form a part of the drainage pattern in the flood plains areas.

There are no natural lakes in the county. However, a few artificial lakes and a number of ponds are scattered throughout the county.

CLIMATE

The climate of Vanderburgh County is continental, humid and temperate, with hot summers and moderately cold winters. The mean annual precipitation is 41.45 inches at Evansville. The mean and extreme temperature and precipitation is listed in Table 1 (7). A little over 13 inches of snowfall annually can be expected in Evansville.

PHYSIOGRAPHY

Vanderburgh County lies wholly in the Wabash lowland province of the state (Figure 4). With respect to its physiographical situation in the United States, the northwestern corner of the

county is in the Till Plains section of the central lowland province and the remainder is in the Aggraded Valley section of the Interior Low Plateaus Province (8).

The Wabash lowland in Vanderburgh County is characterized by intensive areas of alluvial and lacustrine deposits. The evidence of filled-in or aggraded valleys can be observed from the aerial photographs.

TABLE I. Normal and extreme monthly temperatures and precipitation at Evansville, Vanderburgh County, Indiana

Month	Temperature: Mean °F	Temperature: Absolute Maximum °F	Temperature: Absolute Minimum °F	Precipitation: Mean inches	Precipitation: Driest Year (1930)	Precipitation: Wettest Year (1882)	Precipitation: Average Snowfall
January	34.2	72	-18	3.98	6.20	5.95	3.5
February	37.6	79	-23	3.18	3.12	14.62	3.5
March	45.3	87	- 9	4.31	1.97	4.72	2.9
April	57.7	92	24	3.98	1.10	4.17	.4
May	66.8	98	28	4.19	1.02	8.45	.0
June	75.8	106	41	3.74	2.28	5.25	.0
July	78.8	109	47	3.32	1.23	6.05	.0
August	77.3	105	46	3.07	1.29	6.70	.0
September	70.1	107	31	2.87	3.39	3.30	.0
October	59.1	97	21	2.57	1.31	2.25	T
November	44.8	83	- 3	3.16	1.00	3.65	.8
December	36.1	75	- 10	3.08	1.69	5.50	2.2
Year	57.0	109	-23	41.45	25.60	70.61	13.3

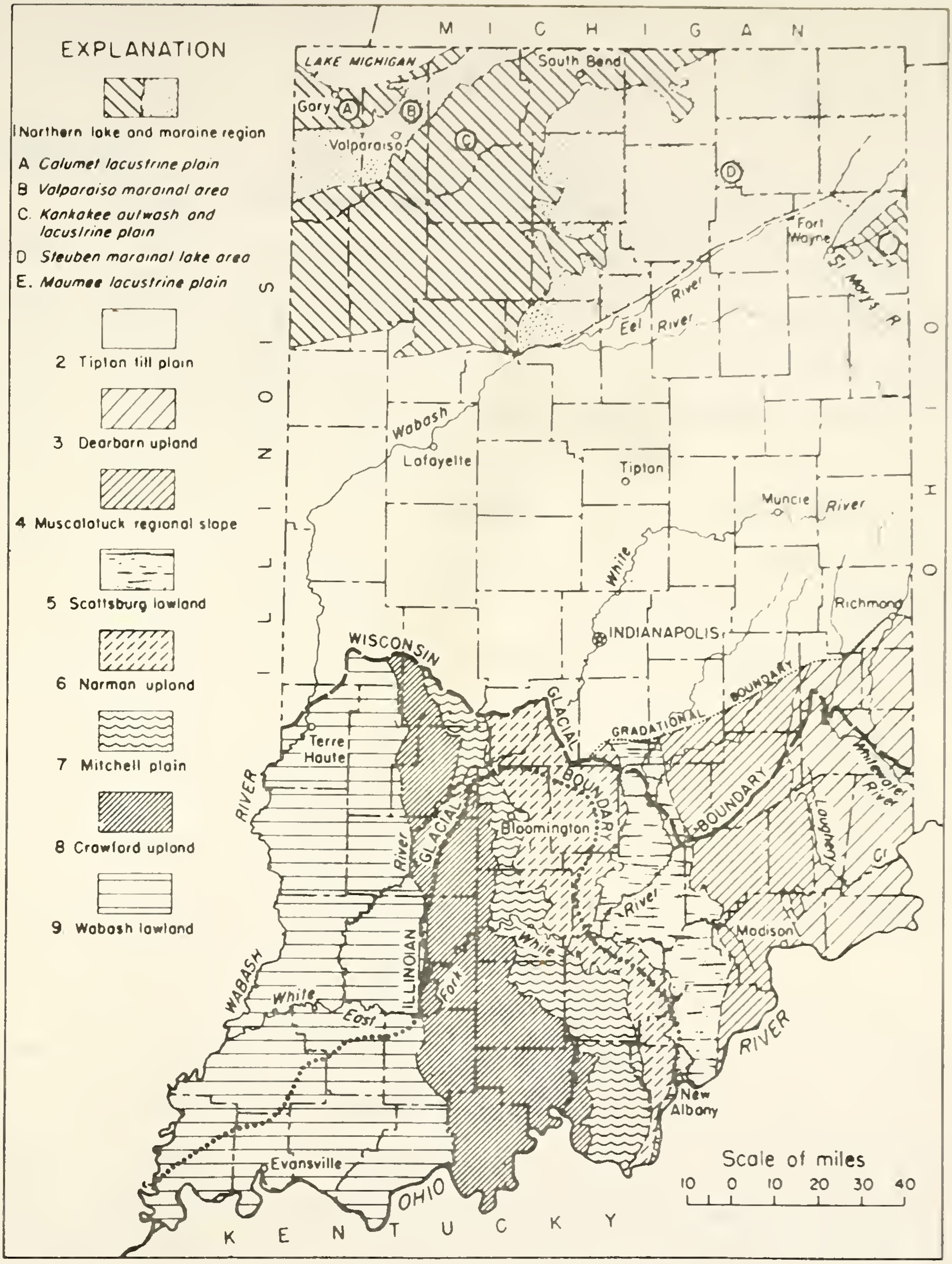


Figure 4 Map of Indiana showing regional physiographic units based on present topography. Modified from Malott

TOPOGRAPHY

The most outstanding topographic feature in Vanderburgh County is the dissected upland between Pond Flat Ditch at the north and Pigeon Creek to the south (Figure 5). The uplands are long and narrow ridges two to seven miles in length with a slight change in elevation. Sharp V-shaped valleys generally over one hundred feet in depth are eroded into this upland plains.

A more gentle rolling topography is found in the north and eastern parts of the county. The hills are rounded and smaller in size. The gradient of streams is not as great but the valleys are wider and separated from one another by broad and nearly flat divides.

A flat and huge upland plain may be observed at the north-western part of the county from the topographic map (Figure 5). This is the lacustrine deposit of Glacial Lake Patoka formed during the Illinoian glacial period (9). The elevation of this plain varies from 420 to 450 feet above sea level.

About half of the county along the Ohio River and Pigeon Creek falls below an altitude of 400 feet above sea level (Figure 5). This region has a very flat topography. The northern part, toward the upland, is a gently sloping aggraded valley. The middle part along Pigeon Creek and its tributaries, Little Pigeon Creek and Locust Creek, is the slack water or lacustrine plain developed during the Wisconsian glacial period. The plain is extremely flat and the altitude of this deposit varies from 382

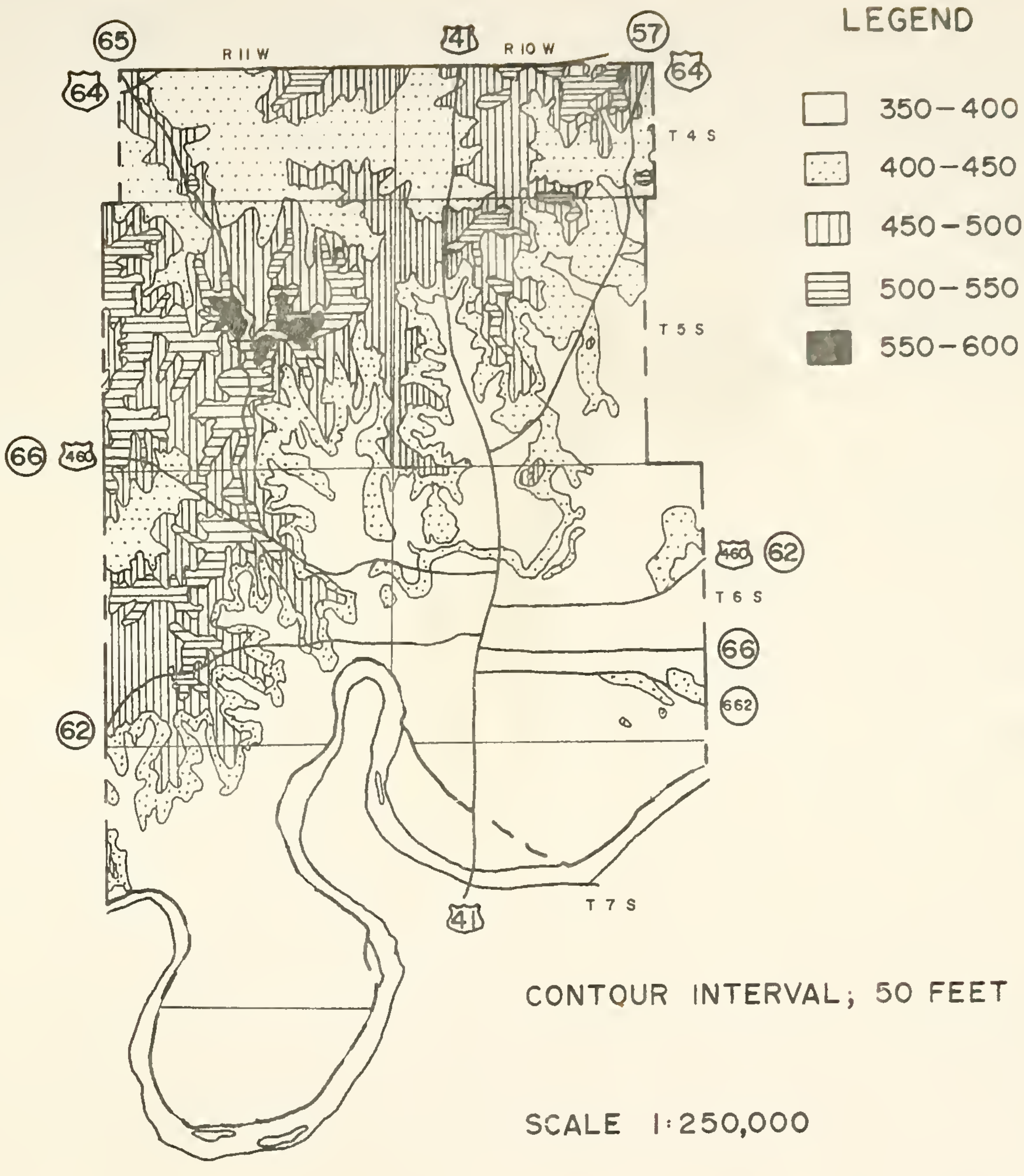


FIG. 5 TOPOGRAPHIC MAP OF VANDERBURGH COUNTY

feet to 400 feet above sea level.

A somewhat level outwash terrace is located south of the slack water plain. The surface of the terrace is slightly higher (ranging from 382 ft. to 390 ft.) at the border with the slack water plain and decreases gradually toward the Ohio River. Current markings are clearly visible from the airphoto mosaic, especially near the southwestern corner of the county. Maximum local relief is about eight feet in this region.

The flood plain adjacent to the Ohio River is characterized by the curvelinear current markings (see Figure 2). The elevation of the flood plain varies from 350 to 368 feet above sea level.

The highest elevation of Vanderburgh County is about 590 feet, at a knob located at the northeastern corner of the county west of SR 57. The lowest elevation is along the Ohio River at the border with Posey County which has a normal pool elevation of 331 feet. Local relief from 100 to 120 feet are not uncommon in the dissected upland region. Maximum relief about 150 feet may be found at the northeastern corner of the county where the highest elevation is reached and at Bayou Creek southwest of Evansville (at Sec. 4 T.7S., R. 11 W.).

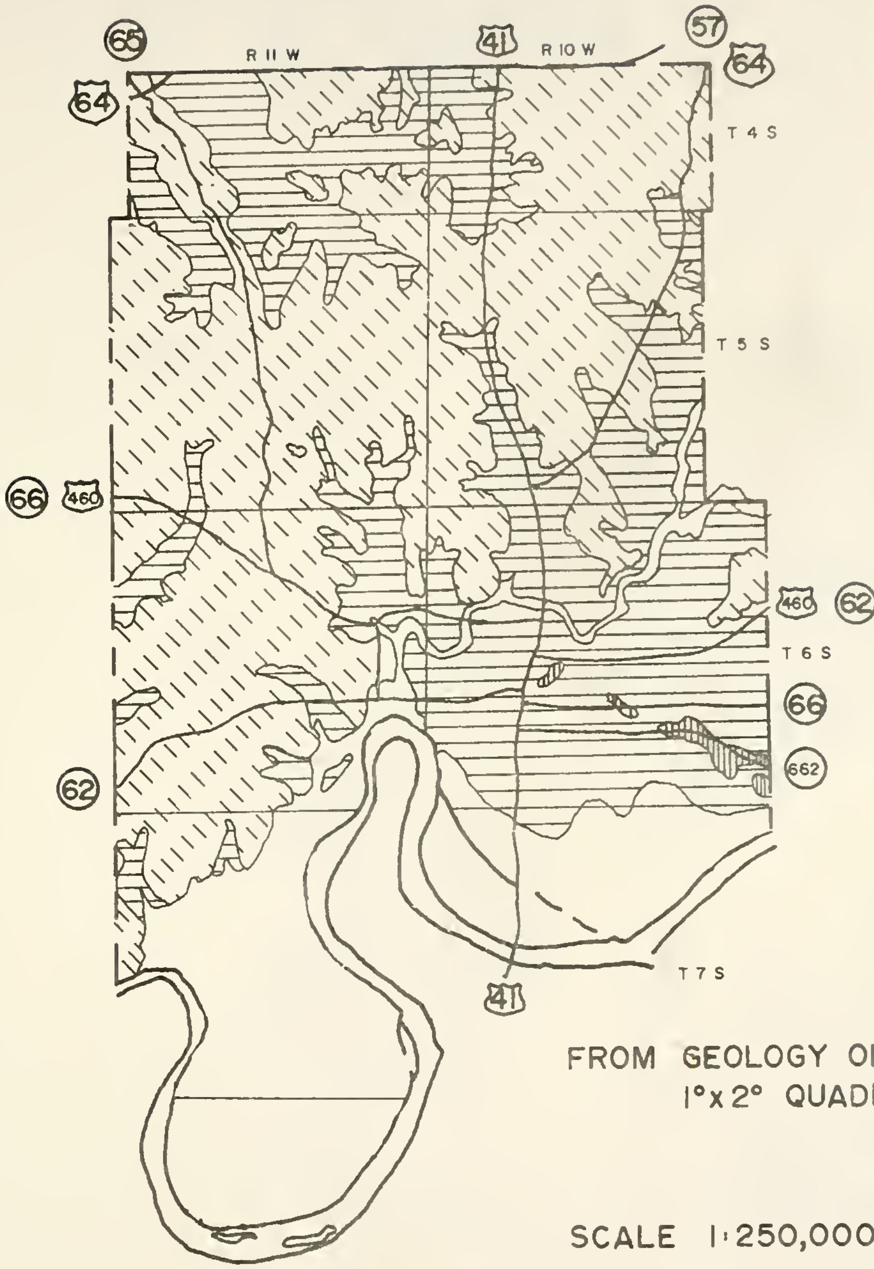
GEOLOGY

The surface and near surface geologic ages represented in Vanderburgh County are the Quaternary period and the bedrock of Paleozoic age. The Quaternary materials are both Pleistocene and recent in age.

The general surface deposits of the county are shown in Figure 6. The area along the Ohio River and Pigeon Creek and many smaller creek valleys not shown on the map is classified as clastic sediments of silt, sand and gravel of the Martinsville Formation by Wayne (10). The area immediately to the north and a large area in the northwestern part of the county is classified as the lacustrine facies of the Atherton Formation. About half of the county belongs to the loess facies of the Atherton Formation. Several small areas between the Ohio River and Pigeon Creek are recognized as dune facies of the Atherton Formation by Wayne.

Although a small portion of the county of the northwestern corner (see Figure 4), is included in the Illinoian drift region defined by Leverett (11), the surface materials are not glacial drift. However, a red colored Illinoian outwash soil is found underlying 125 inches of loess at NW 1/4 of SW 1/4 of Sec. 19, T.4S., R.11W. (see site No. 1, in Figure 7 and Appendix A). Also, a gritty heavy silt loam Illinoian till occurs 85 inches below the surface at the SE 1/4 of NE 1/4 of Sec. 24 of the same township as indicated by Fehrenbacher in his loess distribution study (12).

The bedrocks underneath the unconsolidated surface materials are all of the Pennsylvanian series. The southeastern part of the county is underlain by shale, sandstone, limestone, clay and coal of the Carbondale Group (see Figure 8). The majority of the county



LEGEND

SILT, SAND AND GRAVEL MOSTLY ALLUVIUM, MARTINSVILLE FORMATION OF INDIANA

SAND AND SOME SILT EOLIAN SAND DUNE FACIESS OF ATHERTON FORMATION OF INDIANA

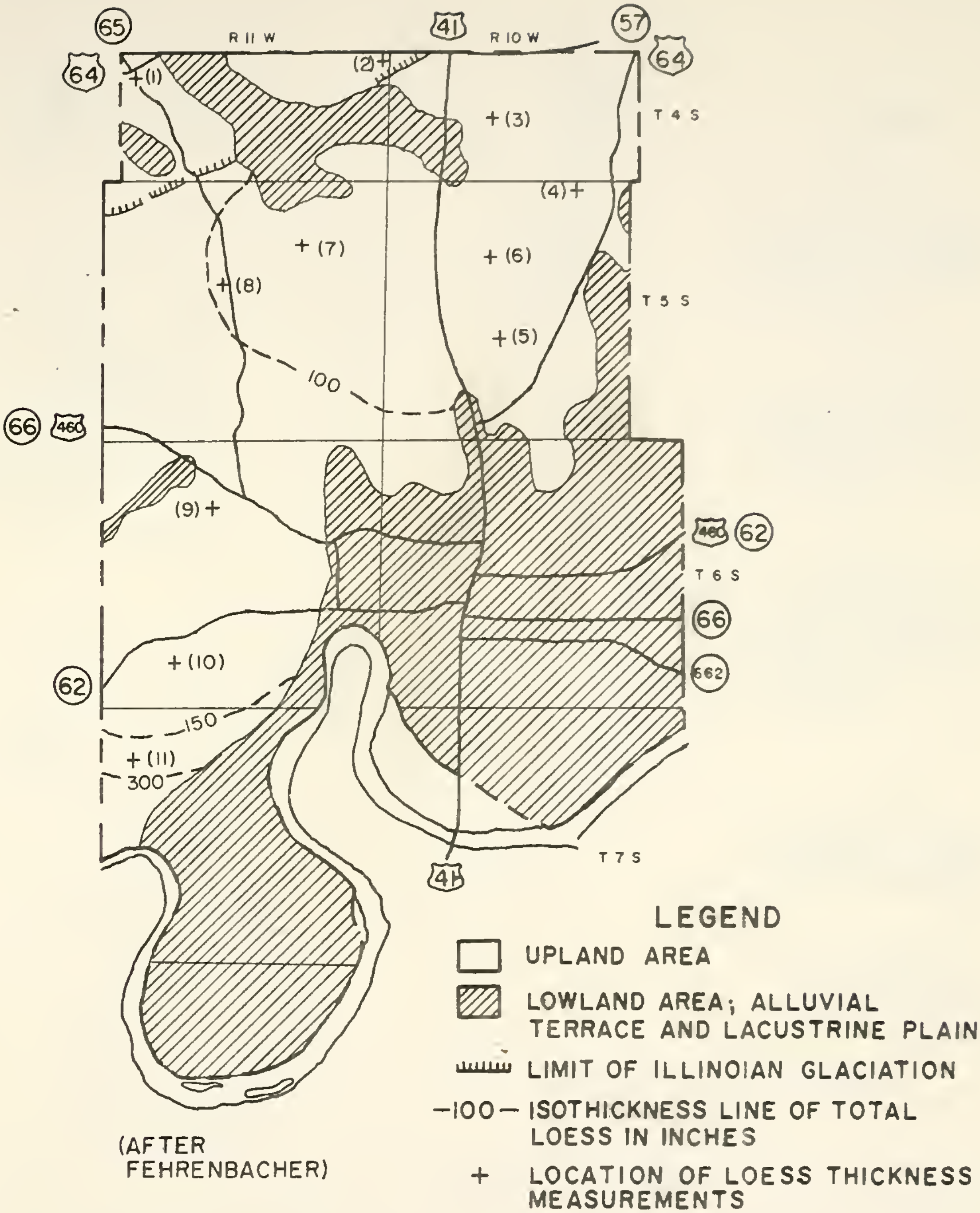
SILT, FINE SAND AND CLAY; EOLIAN SILT, LOESS FACIES OF ATHERTON FORMATION OF INDIANA

CLAY, SILT AND SAND LACUSTRINE DEPOSITS LACUSTRINE FACIES OF ATHERTON FORMATION OF INDIANA

FROM GEOLOGY OF VINCENNES 1°x 2° QUADRANGLE

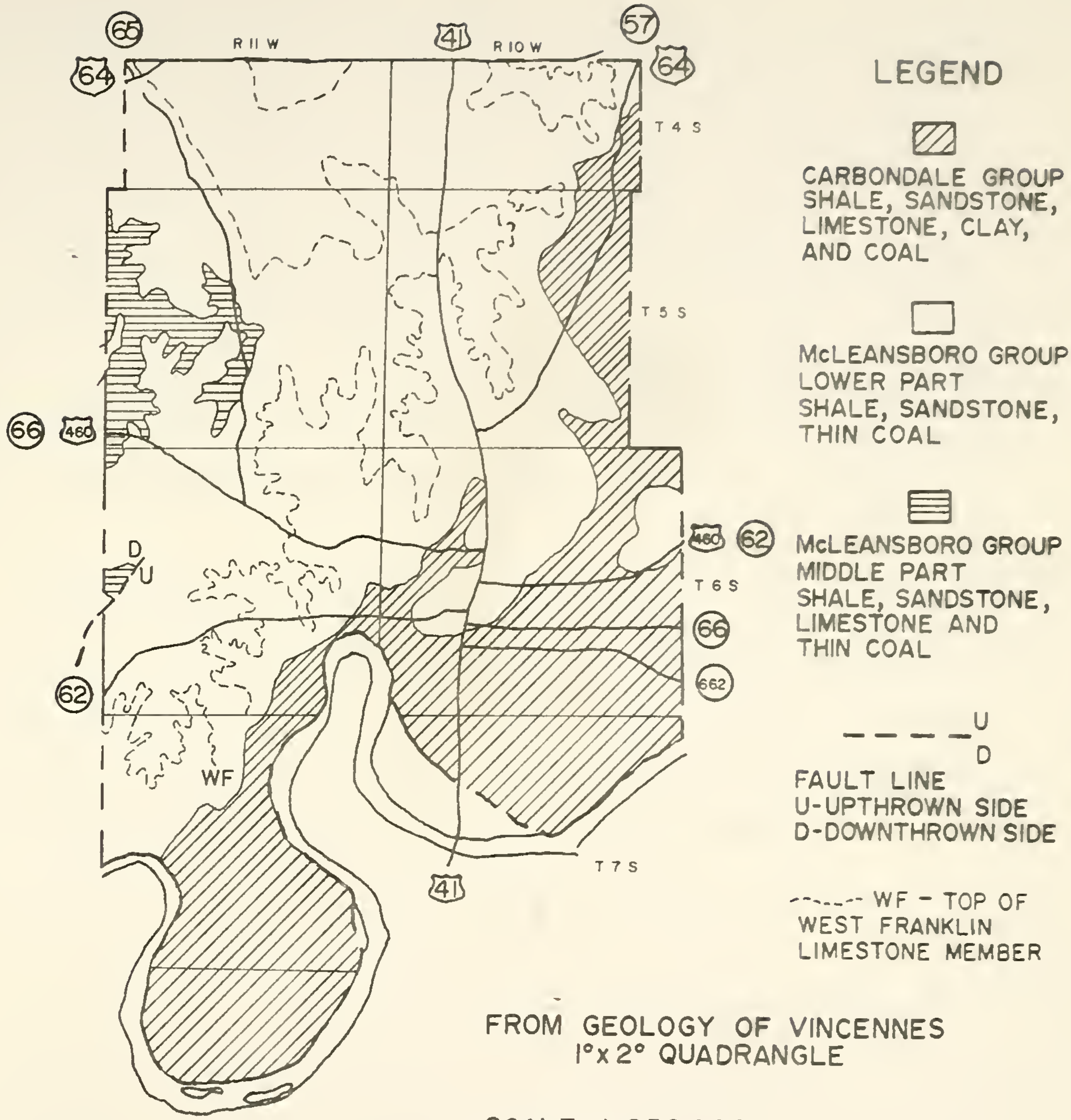
SCALE 1:250,000

FIG. 6 UNCONSOLIDATED DEPOSITS IN VANDERBURGH COUNTY



SCALE 1:250,000

FIG. 7 ISOPACHOUS MAP OF TOTAL LOESS IN VANDERBURGH COUNTY



FROM GEOLOGY OF VINCENNES
1° x 2° QUADRANGLE

SCALE 1:250,000

FIG. 8 BEDROCK GEOLOGY OF VANDERBURGH COUNTY

is underlain by shale, sandstone and thin coal of the lower part of the McLeansboro Group. A small area in the western portion of the county has bedrocks of shale, sandstone, limestone and thin coal of the middle part of the McLeansboro Group.

The top of the West Franklin limestone member within the lower part of the McLeansboro Group is shown as a dashed line on the map. A fault line is also shown in Figure 8 near the county border at the southwestern quarter. A generalized stratigraphic column of the Pennsylvania formation in this area is shown in Figure 9.

Bedrock exposures are numerous at the deep cuts of highways and railroads especially along I-64 and US 460. The rough gullied land in the sandstone-shale region shows that many gullies are entrenched into the bedrock. Bedrock also can be expected along the deep ravines and along some drainage channels.

TIME UNIT					ROCK UNIT		
PERIOD	EPOCH	MAP UNIT	THICKNESS (FEET)	LITHOLOGY	SIGNIFICANT MEMBER	FORMATION	GROUP
PENNSYLVANIAN	CONEMAUGHIAN	P_5	175+		MEROM SS.	MATTOON FM	MC LEANSBORO
		P_4	150 TO 200		LIVINGSTON LS. SHOAL CREEK LS.	BOND FM.	
		P_3	200 TO 350			PATOKA FM.	
		--WF			WEST FRANKLIN LS.	SHELBURN FM.	
	ALLEGHENIAN	P_2	300 TO 400		DANVILLE COAL (VII)	DUGGER FM.	CARBONDALE
		—V			SPRINGFIELD COAL (V)	PETERSBURG FM.	
					SURVANT COAL (IV)	LINTON FM.	
		P_1	250 TO 500		SEELYVILLE COAL (III)	STAUNTON FM.	RACCOON CREEK
	POTTSVILLIAN	—B			BUFFALOVILLE COAL LOWER BLACK COAL	BRAZIL FM.	
						MANSFIELD FM.	

FIG. 9 GENERALIZED STRATIGRAPHIC COLUMN OF PENNSYLVANIAN FORMATION IN INDIANA

LAND FORM AND ENGINEERING SOIL AREAS

The engineering soils in Vanderburgh County are derived mainly from unconsolidated materials (see Figure 6). The unconsolidated materials include fluvial deposits and eolian deposits. A very limited area may be considered as residual soil or non-soil area. However, due to the scale limitation of the attached soil map many narrow strips of rock outcrops along the valley wall of streams and deep highway and railroad cuts cannot be shown.

The entire county essentially is covered by loess deposits of various depths as indicated in Figure 7 and Appendix A. The deepest deposit occurs at the southwestern corner of the county and the depth decreases toward the northeastern corner. The depths of loess are measured on the flat areas where erosion of the deposit is at a minimum. Therefore, the soil areas within this region are subdivided according to the depth of the loess deposits and its erosional conditions.

The deposits of transported materials are not homogeneous and variation should be expected. General properties and profile of the soils for each area of different land form, are presented in this report.

EOLIAN DEPOSITED MATERIALS

There are extensive eolian (wind) deposits in Vanderburgh

County. The eolian deposit is subdivided into two groups: sand deposits and loess deposits.

1. <u>Windblown Sand Deposits</u>:

   Windblown sand deposits are very limited in Vanderburgh County. They occur only on the Ohio River terrace east of Evansville and adjacent to the slack water plain to the north. The deposits are in a dune or ridge form. A prominent dune is located just east of US 41. The largest dune lies along SR 66 a little over one mile east of Evansville. Others were small ridges only a few feet above the surrounding land.

Although the materials of the sand dunes are predominantly fine uniform windblow sand, a considerable amount of silt and clay particles are mixed with the sand. The texture of the dunes is finer toward the eastern county line. The northern slopes of the dunes also are somewhat silty in texture. Boring data along US 41 at sites number 109 and 110 illustrated this phenomenon. These sites are located on the toe of the dune. The surface of site 110 is on the south slope about two feet higher than the surrounding terrace. The soil is classified as dense sandy loam A-4 (4) to a depth of 7 1/2 feet. The composition of the soil consist of 54% sand, 42% silt and 4% clay (see Appendix B). Site No. 109 is located 220 feet north of site No. 110 and two feet higher in elevation. The soil texture is a silty clay A-6 (8) to a depth of 10 feet. The composition of the deposit

is 1% sand, 69% silt and 30% clay.

In general on the higher dunes the soil profile of the sand dune deposit consist of a fine sandy loam or silt loam top soil and a fine sandy loam to a silty clay subsurface soil and underlain by a loamy fine sand. On the lower dunes the terrace material of statified sand, silt and fine gravel may be encountered below a depth of three to nine feet.

Since the sand dune deposits in Vanderburgh County vary widely in texture, engineers should be aware of the different characteristics of the silty and sandy soils and design accordingly.

2. Windblown Silt Deposits

All of the uplands in Vanderburgh County are covered by windblown silts or loess. The loess deposits are subdivided into groups according to the depth of the loess and the type of underlying materials. The subdivisions are: (1) Moderately deep loess deposit, (2) Loess covered lacustrine deposit, (3) Loess covered sandstone-shale, (4) Loess covered Illinoian drift and (5) Sandstone-shale with a loess veneer.

(1) Moderately Deep Loess Deposits

About half of the upland area in Vanderburgh County is considered as moderately deep (above six feet and up to 15 feet) loess deposit. Most of the area in this region has a loess cover from six to ten feet in depth. The loess deposits

are thicker (up to 12 feet or more) at the northwestern corner and the southwestern quarter(from 12 to 15 feet in depth) of the county.

The thick loess deposits occur all on the ridge tops where erosion is at a minimum. The depth of the loess decreases rapidly toward the streams and gullies.

The loess deposits in Indiana have been mapped previously by Moultrop on a regional basis (13). Some minor changes or refinements have been made for this county engineering soils map.

The elevations of the ridge tops vary only slightly in many places. In large or wide areas the topography is undulating. Surface drainage ways are well developed along the major streams. The typical fond-like drainage pattern for deep loess deposits occurs only occasionally.

The soil profile of the moderately deep loess deposit has a silt loam or silty clay loam (A-4 or A-6) soil in the A-horizon. The B-horizon is a more plastic silty clay loam to silty clay soil (A-6 to A-7-6). The C-horizon ranges from silt loam to silty clay loam (A-4 to A-6) soil. The interbedded sandstone and shale bedrock generally occurs more than eight feet below the surface. At the northwestern corner of the county Illinoian drift may be found under the loess deposit.

Soil boring data along I-64 and US 460 verify the profile. Station Nos. 77 and 78, which show an A-4 soil throughout the entire profie, are the only exception from the general pro-

file (see Appendix B).

The engineering problems in this area is primarily the control of moisture during the construction and compaction of the silty material. The subgrade will become weak under adverse moisture or due to frost action in winter. Pumping is a problem.

(2) Loess Covered Lacustrine Plain

About seven square miles of area in the northwestern corner of Vanderburgh County is recognized as a loess covered lacustrine plain. The deposits have a gently undulating topography. The altitude of the deposits is about 450 feet above sea level and about 20 to 30 feet higher than the adjacent lacustrine plain. The topographic breaks between this region and the moderately deep loess deposit and the flat lacustrine plains are very strong and definite.

The characteristics of the lacustrine plain is obliterated entirely by the loess blanket. Surface drainages are poorly developed. Occasionally a phantom drainage pattern appears in this region.

The soil profile is essentially the same as that of the moderately deep loess deposits. The top soil varies from a silt loam in high positions to a silty clay with considerable amount of organic material in the low depressions. The B-horizon is more clayey in texture which ranges from silty clay loam to silty clay (A-4 to A-6 soil and A-7-6 at lower area). The C-horizon is composed of silty clay loam to silty clay (A-4 to A-6) soil. The underlying lacustrine deposits varies from

silty clay to clay (A-6 to A-7-6) as illustrated at boring sites Nos. 8, 9, and 10 along I-64 (see Appendix B).

Special problems associated with this soil are essentially the same as those in the moderately deep loess region. However, if deep cuts are required, the problem of weak support of the lacustrine deposit should be taken into account.

(3) Loess Covered Sandstone-Shale

The area diagonally across the county from the southwest to the northeast is recognized as loess covered sandstone-shale area. This area is dissected by rock controlled streams and gullies. The topography varies from gently rolling to hilly, sloping toward the major channels. The influence of the bedrock is clearly in evidence at the highway and railroad cuts. The best exposure (more than one half mile in length) of the sandstone and shale is located along a deep Pennsylvania Central railroad cut between sections 13 and 14 of T.5S., R.11W, about 1 1/4 miles southwest of Darmstadt. The rock exposure can be recognized from the examination of the aerial photographs.

The surface drainage in this area is well developed. It is controlled by the underlying sandstone and shale bedrocks and exhibits a rectangular drainage pattern.

The upper soil profile is derived from the loess material. Therefore, it is essentially the same as the soil profile of the moderately deep loess deposits. The top soil is primarily a silty clay loam (A-4 to A-6) soil. Soils classified as silt

loam (A-4) and silty clay (A-6) are also found in the top layer. The subsurface soil is predominantly silty clay loam (A-4 to A-6) soil. The weathered sandstone-shale residual soil may be found as sandy loam, silt loam or clay loam under the loess deposits. Rock fragment may be present in quantity toward the sandstone and shale bedrocks.

The soil profile of this area is illustrated by the soil boring data along US 460. A soft sandstone is encountered five feet below the ground surface 650 feet west of boring site No. 67 (14). Sandstone is found at a depth from 3.5 to 4.5 feet from the surface at the bottom of a gully located about 350 feet south of site No. 71. A number of sites in this region showed a thicker loess on account of their topographies. The area is too small to differentiate as moderately deep loess areas on the engineering soils map.

The engineering problems are generally associated with the outcropping of the bedrock material. A shallow cut and fill may encounter several different materials in a short distance.

(4) Loess Covered Illinoian Drift

A small area about one and one half square miles in area located near the center of the northern county border is mapped as loess covered Illinoian drift. The area is bounded by the lacustrine or the slack water plain on the south and the east and the moderately deep loess and sandstone-shale region to the west.

The altitude is considerably lower (50 to 70 feet) than the deposits on the west. Undulating to gently rolling topography still prevail. This may be a good indication of the influence of the sandstone-shale bedrock and the shallowness of the Illinoian drift.

The upper horizons of the solum derived from the loess are the same as that of the loess covered sandstone-shale soil. The A-horizon is a silt loam to silty clay loam (A-4) soil. The B-horizon is slightly more plastic ranging from a silty clay loam to silty clay (A-4 to A-6) soil. The C-horizon varies from a silt loam to clay (generally A-6) soil.

Boring sites along I-64 taken at sites Nos. 35 and 36 showed a silty clay loam (A-4 to A-6) soil. At site No. 39 a sample taken 13.5 to 14.5 feet below the surface is a clay loam (A-4) soil. At site No. 43, clay (A-6) soil is found at a depth of 8.0 to 10.0 feet below the ground surface. The boring at site No. 37 shows the residual soil of sandstone and shale from 10 to 20 feet below the surface of the knob.

As mentioned previously, a gritty heavy silt loam of Illinoian till was found 95 inches below the surface at site No. 2 (Figure 7) by Fehrenbacher (see Appendix A).

The engineering problems associated in this area are those of supporting power in cuts, compaction and erosion of side slopes.

(5) Sandstone-Shale With Loess Veneer

The sandstone-shale with loess veneer soil is scattered

across the county from the northeastern corner to the southwestern quarter of Vanderburgh County. This soil is confined to the valley wall areas where erosion has removed not only most of the loess deposit but some of the residual soils of the sandstone and shale. The topography of this region is extremely rugged and blocky. Gullies have carved into the sandstone-shale bedrock at their upper reaches. Gullies are numerous and closely spaced. A white fringe which reflects the bare soils or rocks of the area can be seen on the aerial photographs.

The central part of the area has lost all or much of the surface soil by erosion. In places, part of the subsoil has been lost leaving a truncated soil profile. Only at the lower reach of the gullied areas where the slopes are more gentle is the surface soil retained to support the growth of vegetation or timber.

The soil profile varies greatly depending on its topographic position and erosional situation. On a normal soil profile a silt loam or silty clay loam (A-4) top soil prevails. It is underlain by a slity clay loam or silty clay (A-4 to A-6) soils. The residual soils with a texture of sandy loam, loam or clay loam may be found with considerable amount of stone fragments before the interbedded sandstone and shale bedrock is reached. In places, where the erosion is severe, the top layers may be removed and the underlying bedrock exposed. This may be con-

sidered as non-soil area.

Boring data along US 460 in the vicinity of sites Nos. 68 and 69 showed that the residual clay loam (A-4) soil is found only one to three feet below the silt loam surface layers. The sandy loam (A-4) soil taken at a depth of five to six feet from the surface at site No. 69 is a weathered sandstone.

The engineering problems associated with this region is associated with the cuts and fills. Different types and characteristics of residual soils or bedrock may be encountered within short distance. Soil stabilization or erosion and gully control is another problem for the engineer.

FLUVIAL DEPOSTITED MATERIALS

About half of Vanderburgh County is covered by fluvial deposited materials. Five different land forms created by the action of water namely, lacustrine (slack water) plain, terrace, flood plain, colluvial slope and clayey depression are discussed.

(1) Lacustrine (slack water) Plain

Two separated lacustrine or slack water plains are recognized in Vanderburgh County. The smaller one is located at the northern part of the county along Pond Flat Ditch and Upper Big Creek. The larger plain lies in the south along Pigeon Creek and its tributaries: Blue Grass Creek, Little Pigeon Creek and Locust Creek. The northern lacustrine plain is the extension of glacial Lake Cynthiana in Gibson County and the head waters of glacial Lake Solitude in Posey County during Illinoian glaciation (15). The southern lacustrine plain is a slack water plain formed during

the Wisconsian glaciation period and more recent periods of flooding.

The northern lacustrine palin varies in altitude between 420 to 450 feet above sea level. The surface is smooth and devoid of natural surface drainage development. However, ditches are dredged to facilitate the drainage. The slack water plain on the south also lacks natural surface drainage systems except along the banks of Pigeon Creek and the main channels of its tributaries. Short and steep gullies have been cut into the lacustrine deposit. The altitude of this plain varies only a few feet (382 to 390 feet). The uniform dark tone of the plain is broken occasionally by scattered small light tonal mounds which indicates a better drainage position of the slightly higher thin loess deposits on the lacustrine plain. Since the mounds are small and the loess mentle is thin no separation is made on the engineering soils map.

The lacustrine plain on the north contains sheet wash deposits from the surrounding uplands. The topography is higher and the texture is coarser toward the upland surface. Some of the areas included in the lacustrine plain may be considered as alluvial (sheet wash) deposits. The delineation between the two is difficult in many places. The slack water plain along Pigeon Creek is much more level and is more silty clay in texture.

Both lacustrine and slack water plains are covered by a

loess veneer (from 4 to 36 inches). The soil is developed partly from the thin loess cover and partly from the sheet wash materials from the uplands. The top soil varies from a silt loam to a silty clay loam. The texture of the B-horizon ranges from a silty clay loam to clay. Stratified silty clay loam, silty clay and clay are found underneath the subsurface soil. At the slightly low areas the top soil may contain some organic matter and has a silty clay to clayey texture. The B-horizon is silty clay to clay without organic matter. Stratified clay and silty clay is found as the parent material.

Boring data along I-64 at sites Nos. 44, 45, and 46 indicate that the top soil is a silty clay loam (A-4) to silty clay (A-6) soil. The B-horizon is a silty clay loam (A-4) soil and the C-horizon is a silty clay loam to silty clay (A-4 to A-6) soil.

Boring data of the southern slack water plain along US 41 show that the A-horizon varies from a silt loam to silty clay loam (A-4 to A-6) soil with the exception of sites No. 100 and 107 where clay soils (A-7-5 and A-7-6) were found. The clay soil of the first five feet at site No. 100 contains 14.0% of gravel, 17% of sand, 38% of silt and 31% of clay (16). At site No. 103 the first nine feet from the boring contains 15% of gravel, 19% of sand, 54% of silt and 12% of clay and is classified as silt loam (A-4) soil (16). This layer is followed by two feet of sandy loam (A-4) soil which is composed of 60% of sand, 28% of silt and 12% of clay. This unusual coarse texture of the deposits at these sites may be attributed to the proximity

of Pigeon Creek channel and the Ohio River terrace.

Boring data along SR 66 at site No. 93 shows that the soil from the surface down to ten feet in depth is a silt loam (A-4) soil which contains only 1% of sand but 84% of silt and 15% of clay.

The engineering problems associated with the lacustrine or slack water plain are high water table, low load carrying capacity and settlement for heavy structures.

(2) Terrace Deposits

A large terrace deposit along the Ohio River is recognized in Vanderburgh County. Current scars occur in the eastern, and western portions of the terrace. However, infiltration basins which are a common feature for coarse-textured terrace deposits are absent. The terrace has a flat topography with a maximum altitude of about 392 feet on its northern edge and decreases gradually down to 376 feet near the Ohio River flood plain. The boundary between the terrace and the slack water plain to the north is very difficult to define accurately especially in the area within the city of Evansville. At the southeastern corner and the southwestern corner the terraces are several feet lower in elevation (about 370 feet) than the rest. They may be considered as low terraces and have been delineated by dotted lines on the engineering soils map.

The texture of the terrace varies greatly from place to place. On the high terrace the surface soil ranges from a sandy loam to silty clay loam. The B-horizon varies from sandy loam to silty

clay. On the lower terrace and the lower topographic position of the high terrace, the surface soil is a clay loam or clay. The subsoil is a silty clay or clay. The stratified materials consisting of silt, sands and fine gravels usually occur at a depth of 10 to 12 feet below the surface. Mica flakes are present in the Ohio terrace deposits.

Boring data along SR 66 and US 41 show that the surface soil is mostly a silty clay loam (A-6) soil which consists of 1% sand, 76% silt and 23% of clay (17). At site No. 90 the soil composition contains more sand (1% gravel, 10% sand, 68% silt and 21% clay) and is classified as silt clay loam(A-4) soil. The 3.5 feet top layer of soil at site No. 89 is more sandy (22% sand, 73% silt and 5% clay) and is classified as silt loam (A-4) soil (17). At site No. 91 the first six feet is classified as clay loam (A-6) soil which consists of 36% sand, 38% silt and 26% clay. The top two feet of soil is classified as clay (A-6) soil at site No. 118 (18). The subsurface soil varies from sandy loam to clay (site No. 115). Sand was found at site No. 86 (see Appendix B). However, this site is located on the edge of the roadway and the four feet layer of sand sandwiched between silt clay loam (A-6) soil with a trace of organic material is probably embankment material (17). Sandy loam (A-4 to A-2-4) soils are commonly found underneath the subsurface soil. No appreciable amount of gravels were found in all these borings. This fact is verified by the absence of gravel pits on this terrace.

Settlement problems can be expected in this area. For heavy structures, the subsurface soil should be investigated thoroughly.

(3) Flood Plains or Alluvial Plains

Vanderburgh County has a relatively large amount of flood plains. The extent of mapping of these plains was determined by the scale of the engineering soils map.

Due to the different sources of the alluvial materials and the forms of their deposition the flood plains in this county are subdivided into the Ohio River flood plain and the alluvial plains of the aggraded valleys.

(A) The Ohio River Flood Plains

The Ohio River flood plains are subdivided into two groups according to their texture namely: sandy texture and fine texture,

(a) Sandy-Textured Flood Plains

Three narrow strips on the Ohio River flood plain are considered as sandy-textured flood plains. They are located on the southwestern and the southeastern corners of the county.

The sandy-textured flood plains are situated near the Ohio River channel and are slighly higher than the surrounding flood plains. The coarseness and the thickness of this sandy alluvial material varies with the distance from the river bank. In places, deposits of six feet or more in thickness are common (3). Subsequent floods have changed the deposits as some sand smars may have been scoured away. The mapped area (dotted lines with sandy

textured symbol) was based on the 1940 aerial photographs.

The soil profile consists of a sandy loam to silty clay loam top soil, a fine sand or loamy fine sand subsoil and stratified loam, silt loam, and sandy loam substrata.

(b) Fine-Textured Flood Plains

The major part of Ohio River flood plain belong to this category. The flood plain has a nearly flat surface except where broken by a series of low current scars. The altitude varies from 350 feet near the Ohio River to 368 feet above sea level near the terrace. The flood plain deposits range from 107 to 119 feet in thickness in this county (9). Surface drainage is channeled along the sloughs or scars created by the currents of the flood waters.

The surface soil varies from silt loam to clay. The subsurface soil also varies from a sandy loam to clay. Stratified loam, silt loam, and sandy loam is found further down.

The profile along US 41 (sites Nos. 122 to 132) reveal the fact that silty clay (A-6 to A-7) soils are found beneath about six inches of top soil in all the sites except Nos. 122 and 123 (19). Site No. 122 taken at the bottom of Bee slough showed four feet of clay (A-7-5) underlain by five feet of silty clay(A-6). At site No. 123 9.5 feet of clay (A-7-5) soil is found underneath about six inches of top soil. The substrata consists of silty clay, or silty clay loam (A-4 to A-6) soil. In general, the composition of the deposits is about equal distribution of silts and clays.

The major engineering problem in this area is associated

with flood or high waters, the danger of scour and the weak supporting power of the unconsolidated deposits.

(B) Alluvial Plains of the Aggraded Valleys

All the alluvial plains except those along the Ohio River in Vanderburgh County belong to this category. The depth of these deposits ranges from a few feet at the head water area to more than 100 feet at the lower reaches of the streams. The deposits of the alluvial plain are derived from the erosion of the surrounding loess covered sandstone and shale uplands. The highly erosive loess fills the valleys with silty deposits. The alluvial plains slope gently from the upper reach toward the lower reach with a steeper gradient at the upper ends. Channels are dredged and straightened to facilitate drainage of the valleys.

Since the soil of the region is derived from the uplands, coarse-textured materials may be expected adjacent to the foot of the upland and finer-textured materials further down stream. The soil profile varies from a fine sandy loam to a silty clay loam top soil, with a silty loam or a silty clay subsurface soil which is underlain by stratified silt, sandy loam, sand, clay or silty clay loam. The substrata correlates with the materials of the adjacent uplands.

Boring data along I-64 across Big Creek at site Nos. 12, 13 and 14 indicate the top soil is a silty clay (A-7-6) soil. The subsoil is a silty clay loam or silty clay (A-6) soil. Silt loam (A-4) soil which contains more than 80% of silt is

found at depth in the profile (see Appendix B).

The boring profile along US 460 across South Fork Big Creek at site No. 66 shows that the first eight feet of soil is a loam (A-4) soil which contains 1% of gravel, 44 % of sand, 46% of silt and 9% of clay (14). A five-foot layer of sandy loam (A-4) soil, composed of 5% of gravel, 65% of sand, 29% of silt, and 1% of clay, underlies the top layer (14), which in turn, is underlain by 4.5 feet of silty clay loam (A-6) soil and 10.5 feet of loose silt loam (A-4) soil (see Appendix B). The hard clay loam or weathered shale is reached at a depth about 28 feet below the ground surface.

Sites Nos. 83, 84 and 85 are located in the alluvial plain of Locust Creek. The top layer of soils at sites Nos. 84 and 85 (two to five feet in thickness respectively) are silty clay fill (A-6) soil. The original soil is shown from the boring data at sites Nos. 83 and 85. Both soils are classified as A-4 soil (about 68% of silt and less than 20% of clay) by the AASHO classification but is called silty clay loam at site No. 83 and silt loam at site No. 85. Sandy loam (A-4) soil is found about five feet below the surface at site No. 83. Silty clay and silty clay loam (A-6) soils are encountered at site No. 84 (20).

The engineering problems in this area are associated with high water and frequent flooding. Subgrade support is poor during the wet season. Settlement may become a problem for heavy structures.

(4) Colluvial Slope Deposits

There are a few areas in Vanderburgh County that are considered as colluvial deposits. Most of the deposits are located along the drainage channels and the lacustrine or slack water plains in the northeastern quarter of the county. The colluvial deposits exhibit an apron-like land form. The surface is generally smooth and sloping gently toward the stream channel or basin.

The soil of the colluvial deposit is very similar to the soil of the surrounding area except that it has been washed down from the uplands. The general soil profile consists of a silt loam to a silty clay loam surface and subsurface soil, a silty clay loam subsoil and a silt loam to a silty clay parent material. The texture of the deposit may vary depending on its topographic position and the material of the adjoining upland.

Problems in this area are likely to be the weak supporting power and excessive settlement of the unconsolidated deposit.

(5) Clayey Depressions

On the Ohio River terrace and flood plain in Vanderburgh County there are numerous long narrow flat depressions or drainage channels recognized as clayey depressions. Since the depressions are narrow in width only those larger ones located on the terrace are mapped on the accompanied soil map.

The depressions are slightly lower than their adjacent broad flats and registered a darker tone on the airphotos. Some of the depression or sloughs are wet for a considerable period of the year. Ditches were dug extensively in the sloughs to fa-

cilitate the removal of the surface waters.

The surface soil varies from a silty clay loam to a clay. The subsurface soil is a more plastic silty clay or clay. Stratified clay or silty clay and sand are found further down the profile.

Problems in this region is mainly associated with drainage. High water table coupled with the poorly drained plastic clayey soil reduces the supporting power of the soils considerably.

MISCELLANEOUS

Borrow Pits

Four borrow pits of considerable size are recognized on the Ohio River bottoms in the 1940 airphotos. The borrow pits have been stripped of their upper soil layers to provide earth for road beds, levee or other types of embankments. Most of them are now depressed areas without adequate external drainage. Water likely stands in them most of the year.

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APPENDIX A

Loess Thickness Measurements in Vanderburgh County by J. B. Fehrenbacher

Site No.	Location Description Township	Range	Section	Total Depth in inches	Underlying Material
1	4S	11W	19, NW1/4SW1/4	100	Red Illinoian outwash soil
2	4S	11W	24, SE1/4NE1/4	95	Gritty heavy silt loam Illinoian till
3	4S	10W	28, NW1/4SE1/4	80	Shale residium
4	5S	10W	2, NW1/4NW1/4	75	Sandstone soil
5	5S	10W	21, NW1/4SE1/4	85	Sandstone soil
6	5S	10W	9, SE1/4SW1/4	80	Sandstone soil
7	5S	11W	11, NW1/4SE1/4	85	Sandstone soil
8	5S	11W	16, NW1/4NE1/4	95	Sandstone Soil
9	6S	11W	9, SE1/4NW1/4	115	Sandstone soil
10	6S	11W	29, SW1/4SE1/4	120	Sandstone soil on sandstone
11	7S	11W	7, NE1/4NE1/4	130	Sandstone Soil

APPENDIX B

Soil boring data along I-64

The soil test data tabulated below was obtained from consultants' reports prepared for the Indiana State Highway Commission. The location of the site is shown on the attached engineering soils map. Additional data and soil profiles are contained in the consultants' reports (21,22,23).

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent				L.L.	P.L.	P.I.	S.L.
						Gravel	Sand	Silt	Clay				
1	984+00	37Lt	4.0-6.0	A-4(8)	SiL	0	1	81	18	29	24	5	21
2	990+00	37Lt	2.0-4.0	A-6(11)	SiCl	0	1	68	31	39	21	18	20
			4.0-6.0	A-6(9)	SiCl	0	5	63	32	31	19	12	17
			8.0-10.0	A-7-6(14)	Clay	5	9	39	47	46	25	21	20
3	996+00	37Lt	0.3-2.0	A-7-6(15)	SiCl	0	0	64	36	46	22	24	20
			4.0-6.0	A-4(8)	SiClL	0	1	77	22	29	22	7	20
			10.0-12.0	A-6(8)	Clay	1	40	21	38	34	17	17	14
4	1002+00	37Lt	4.0-6.0	A-4(8)	Loam	0	1	81	18	26	23	3	22
5	1011+00	37Rt	4.5-6.0	A-6(9)	SiClL	1	9	64	26	33	21	12	17
6	1020+00	37Lt	0.4-2.0	A-6(9)	SiCl	0	3	65	32	36	23	13	18
			2.5-4.0	A-7-6(13)	SiCl	0	2	63	35	43	22	21	16
			4.0-6.0	A-6(10)	SiClL	0	2	68	30	37	21	16	19
7	1026+00	37Lt	4.0-6.0	A-6(9)	SiClL	0	2	73	25	35	23	12	14
8	1031+50	37Lt	12.0-14.0	A-7-6(18)	SiCl	0	5	63	32	48	17	31	12
9	1033+50	37Rt	14.0-16.0	A-7-6(14)	Clay	0	7	46	47	42	19	23	14
10	1038+50	37Lt	12.0-14.0	A-6(11)	SiCl	0	11	56	33	36	18	18	14

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
11	53+00 PR1	12Rt	4.0-6.0	A-6(11)	SiCl	0	5	58	37	37	19	18	14
12	1056+00	37Lt	6.5-8.0	A-4(8)	SiL	0	1	84	15	28	23	5	20
13	62+00PR1	12Rt	0.0-1.5	A-7-6(11)	SiCl	0	2	62	36	42	25	17	22
			4.0-6.0	A-6(10)	SiClL	0	1	76	23	35	21	14	17
14	1064+00	37Lt	20.0-21.5	A-4(8)	SiL	0	8	82	10	28	23	5	20
15	1073+00	37Lt	2.0-4.0	A-4(8)	SiClL	0	3	71	26	29	21	8	18
			4.0-6.0	A-4(8)	SiClL	0	5	70	25	30	21	9	19
16	77+00PR1	12Rt	2.0-4.0	A-6(11)	SiCl	0	1	63	36	39	22	17	17
17	1086+00	37Lt	0.5-2.0	A-7-6(18)	SiCl	0	1	57	42	52	22	30	14
			2.5-4.0	A-7-6(13)	SiCl	0	1	63	36	43	21	22	18
			4.5-6.0	A-4(8)	SiClL	0	1	78	21	29	24	5	21
18	1104+00	37Lt	0.5-2.0	A-6(11)	SiCl	0	3	62	35	39	21	18	19
			4.0-6.0	A-6(9)	SiClL	0	3	71	26	36	23	13	19
19	1119+00	37Lt	2.0-4.0	A-6(11)	SiCl	0	2	66	32	39	21	18	18
20	1128+50	37Lt	0.2-2.0	A-6(11)	SiClL	0	1	75	24	38	21	17	17
			6.0-8.0	A-4(8)	SiL	0	2	86	12	27	22	5	19
21	1131+00	37Rt	10.0-12.0	A-6(10)	SiL	1	9	70	20	32	17	15	15
			12.0-14.0	A-7-6(14)	Clay	1	17	41	41	42	18	24	13
22	1137+00	37Rt	16.0-18.0	A-7-6(12)	Clay	2	23	34	41	41	20	21	14
23	1143+00	37Rt	18.0-20.0	A-4(0)	Sa.L	0	66	16	18	19	NP	NP	17
24	1149+00	37Rt	12.0-14.0	A-7-5(20)	Clay	0	1	9	90	84	31	53	16
25	1162+50AR	37Rt	0.4-2.0	A-7-6(13)	SiCl	0	1	60	39	43	23	20	20
			4.0-6.0	A-4(8)	SiClL	0	0	79	21	32	24	8	21
26	1168+00AR	37Rt	4.0-6.0	A-4(8)	SiClL	0	2	77	21	30	23	7	21

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
27	1214+50	37Lt	0-1.0	A-6(11)	SiCl	0	2	65	33	38.0	21.4	16.6	18.6
			5.0-7.0	A-4(8)	SiClL	0	11	66	23	25.0	20.6	4.4	19.0
			10.0-11.0	A-4(3)	SaL	16	42	28	14	22.4	19.3	3.1	19.2
28	1217+50	37Lt	6.0-7.0	A-4(8)	SiClL	0	8	64	28	26.5	19.8	6.7	16.9
29	1229+75	37Rt	0.5-1.5	A-7-6(11)	SiClL	0	10	64	26	41.2	24.8	16.4	25.8
30	1231+50	37Lt	10.0-11.0	A-4(3)	Loam	0	50	33	17	20.6	18.1	2.5	16.8
31	1238+00	37Lt	21.0-22.0	A-4(8)	SiClL	0	20	55	25	23.7	20.2	3.5	17.8
32	1246+00	37Lt	6.0-7.0	A-7-6(10)	Clay	14	27	23	36	41.9	22.3	19.6	26.2
33	1249+75	37Lt	5.5-7.0	A-4(8)	SiL	0	17	67	16	23.4	19.6	3.8	18.9
34	1255+00	37Rt	7.5-8.5	A-7-6(15)	Clay	0	8	42	50	48.4	24.5	23.9	14.3
35	1258+00	37Lt	0-1.0	A-4(8)	SiClL	0	3	71	26	31.4	23.7	7.7	20.3
			6.0-7.0	A-4(8)	SiClL	0	3	76	21	26.2	21.6	4.6	20.0
36	1275+00	37Lt	5.0-6.0	A-6(9)	SiClL	0	3	73	24	31.4	19.8	11.6	25.4
37	1295+00	37Rt	10.5-11.5	A-4(2)	SaClL	0	54	22	24	20.3	17.5	2.8	6.5
			13.0-14.0	A-7-6(12)	Clay	0	20	24	56	41.7	21.7	20.0	15.3
			19.0-20.0	A-7-6(11)	Clay	0	3	37	60	43.7	26.9	16.8	19.6
38	1307+00	37Rt	2.0-3.0	A-4(8)	SiCl	0	6	63	31	29.6	20.3	9.3	16.8
39	1320+00	37Lt	13.5-14.5	A-4(6)	ClL	0	34	37	28	21.3	13.6	7.7	15.4
40	1329+00	37Rt	0-1.0	A-4(8)	SiClL	0	1	70	29	31.9	23.4	8.5	19.6
41	1341+00	37Rt	4.0-5.0	A-4(8)	SiClL	0	2	75	23	29.7	22.6	7.1	20.9
42	1349+00	37Lt	15.5-19.0	A-4(8)	SiCl	0	3	64	33	29.7	19.7	10.0	23.4
			20.0-24.0	A-6(9)	SiCl	0	2	53	45	35.3	22.3	13.0	19.2
43	1352+00	37Rt	8.0-10.0	A-6(11)	Clay	0	8	50	43	38.7	20.7	18.0	14.3
			16.5-17.5	A-7-6(14)	Clay	0	3	48	49	45.3	22.6	22.7	17.6
44	1363+00	37Rt	6.0-8.0	A-4(8)	SiClL	0	3	72	25	30.2	21.6	8.6	21.0
45	1369+00	37Rt	2.5-3.5	A-6(10)	SiCl	0	1	64	35	35.1	21.1	14.0	21.0

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
			15.0-16.0	A-7-6(15)	Clay	0	7	44	49	45.1	19.9	25.2	13.8
46	1380+00	37Rt	0-1.0	A-6(10)	SiCl	0	1	68	31	36.2	22.4	13.8	13.5
47	1429+00	37Rt	2.0-3.0	A-6(11)	SiCl	0	4	57	39	35.9	19.5	16.4	17.0
48	1438+00	37Lt	1.0-2.0	A-6(8)	Clay	0	28	40	32	31.0	19.0	12.0	16.0
			5.0-6.0	A-4(5)	ClL	0	41	38	20	22.2	16.7	5.5	15.3
49	1455+00	42Rt	5.0-6.0	A-4(8)	SiClL	0	2	72	26	28	20	8	16
50	1462+50	42Lt	7.0-8.0	A-6(12)	Clay	2	17	38	43	38	17	21	21
51	1477+00	42Lt	0-0.5	A-4(8)	SiL	0	3	80	17	NT	NT	NP	NT
			5.0-6.0	A-6(10)	SiCl	1	9	55	35	36	20	16	19
52	1492+25	42Rt	6.0-7.5	A-6(10)	ClL	7	29	35	29	37	16	21	14
53	1501+00	70Rt	17.0-18.0	A-7-6(20)	Clay	1	7	32	60	63	27	36	20
54	1521+00	70Lt	7.0-8.0	A-7-6(12)	Clay	19	20	27	34	44	19	25	16
55	1527+00	70L	3.0-4.0	A-6(9)	SiClL	0	1	74	25	34	22	12	20
56	1527+00	42Rt	1.0-7.0	A-6(10)	SiClL	0	2	68	30	37	22	15	27
			10.5-12.0	A-6(9)	ClayShale	24	6	42	28	35	21	14	16
			13.5-16	A-6(10)	Weathered Shale	1	9	47	43	37	21	16	17
57	1537+00	70Lt	16-17.5	A-7-6(19)	ClayShale	1	1	23	75	55	19	36	11
			19-20.5	A-7-6(18)	ClayShale	2	1	21	76	52	22	30	12

Soil Boring data along US. 460 from consultants' reports (14,20)

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
58	853+30	70Lt	8.0-12.0	A-4(0)	SandyLoam	3	48	30	19	22	13	9	13
59	858+00	70Lt	1-10.0	A-4(8)	SiClL	0	10	67	23	28	18	10	17
			15-20.0	A-2-4(0)	SaL	0	77	14	9	NP	NP	NP	NP
			20-21.0	A-4(0)	SaL	4	64	20	12	20	18	2	16

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
			24-24.4	A-6(10)	SiL	4	7	78	11	37	22	15	20
60	883+00	42Lt	10-12.0	A-7-6(16)	SiClL	3	18	58	21	52	27	25	14
61	897+00	70Rt	2-4.0	A-7-6(12)	SiClL	0	1	76	23	44	26	18	17
			8-10.0	A-6(9)	SiL	0	19	64	17	35	23	12	24
62	901+00	70Rt	12-14.0	A-6(10)	Clay	0	41	25	34	40	17	23	19
			14-16.0	A-4(0)	SaL	0	66	26	8	NP	NP	NP	NP
			16-19.0	A-4(2)	SaL	3	55	35	7	NP	NP	NP	NP
63	904+00	70Rt	17-18.0	A-6(10)	SiClL	0	5	69	26	40	24	16	27
64	914+00	42Lt	2.5-4	A-4(1)	SaL	5	65	29	1	NP	NP	NP	NP
65	921+10	42Rt	7-8.0	A-6(12)	ClL	7	23	45	25	40	21	19	15
66	940+40	42Rt	13.5-15	A-6(9)	SiClL	1	6	72	21	33	20	13	20
			18.5-20	A-4(8)	SiL	0	12	69	19	27	20	7	18
67	954+50	70Rt	4-6.0	A-6(11)	SiCl	0	1	69	30	40	22	18	20
			20-25.3	A-7-6(9)	ClL	14	30	33	23	41	24	17	20
68	1009+20	70Lt	4.5-6	A-4(8)	SiL	0	6	77	17	29	20	9	18
			8.5-9	A-7-5(19)	Clay	3	17	37	43	58	30	28	15
69	1013+00	70Lt	5-6.0	A-4(2)	SandyLoam	12	51	27	10	NP	NP	NP	NP
			11.5-12	A-6(7)	Loam	4	36	46	14	40	28	12	16
			13-14.0	A-7-6(14)	SiClL	2	7	67	24	48	27	21	20
70	1017+00	70Lt	7-9.0	A-4(5)	ClL	2	40	35	23	27	19	8	20
			9.5-14	A-4(2)	SaL	18	48	25	9	NP	NP	NP	NP
71	1032+00	42Lt	6-7.0	A-6(8)	SiClL	0	7	69	24	29	18	11	20
72	1040+00	70Lt	10-12.0	A-6(10)	SiL	3	28	53	16	39	24	15	30
73	1069+00	42Rt	10-12.0	A-4(3)	SaL	6	48	37	9	NP	NP	NP	NP
			13-14.0	A-4(5)	Loam	1	44	46	9	NP	NP	NP	NP
74	1079+00	70Lt	2-4.0	A-7-6(18)	SiCl	0	13	56	31	51	21	30	20

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
75	1080+00	42Lt	6-7.0	A-4(8)	Silt	0	0	80	20	33	23	10	20
			17-19.0	A-2-4(0)	SaL	21	54	14	11	NP	NP	NP	NP
76	1083+00	42Rt	0-1.5	A-4(8)	SiClL	0	12	68	20	26	20	6	20
77	1093+39	42Lt	4.5-6	A-4(8)	SiL	0	19	63	18	24	18	6	20
78	1095+42	42Rt	7.5-9	A-4(7)	ClL	0	32	48	20	20	14	6	18
			13.5-15	A-7-6(5)	SaClL	0	56	19	25	41	21	20	22
79	1116+50	42Lt	4.5-6	A-7-6(19)	Clay	0	12	27	61	56	18	38	10
80	1120+00	42Lt	4-5.0	A-4(8)	SiL	0	12	72	17	28	20	8	24
81	1121+80	5Lt	6-8.0	A-6(10)	ClL	0	30	46	24	31	14	17	15
82	1132+65	42Rt	0-1.0	A-2-4(0)	Sand	11	77	9	3	NP	NP	NP	NP
			5-6.0	A-6(9)	SiClL	0	4	75	21	32	20	12	20
83	1144+00	23Rt	2-4.0	A-4(8)	SiClL	0	13	67	20	26	18	8	21
			5-6.0	A-4(3)	SaL	0	52	34	14	19	13	6	17
84	1147+00	19Lt	0-2.0	A-6(10)	SiCl	1	5	57	37	30	16	14	18
85	1153+00	15Lt	10-12.0	A-4(8)	Loam	0	17	68	15	24	18	6	21

Boring Data along SR66 from consultants' report (17).

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
86	37+90	15Rt	2-4.0	A-1-b(0)	Sand	11	73	12	4	13	NP	NP	NP
87	50+00	26Rt	3-4.0	A-6(10)	SiClL	0	1	76	23	35	19	16	12
88	55+75	21Rt	6-8.0	A-4(1)	SaL	1	59	30	10	18	NP	NP	NP
89	59+40	26Lt	4-5.0	A-7-5(12)	SiCl	4	11	53	32	49	34	15	32
			6-8.0	A-4(8)	SiL	0	22	73	5	NP	NP	NP	NP
90	66+00	26Rt	0.3-3.5	A-4(8)	SiClL	1	10	68	21	29	21	8	18
91	92+50	53Lt	4-5.0	A-6(8)	ClL	0	36	38	26	33	19	14	14

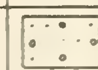
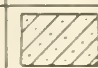
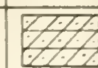
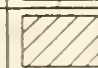
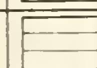
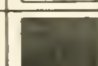
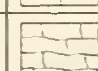
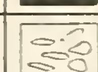
Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
			7-8.0	A-2-4(0)	SaL	0	66	16	18	20	NP	NP	NP
			9-10.0	A-2-4(0)	SaL	1	76	13	10	NP	NP	NP	NP
92	115+00	53Lt	6-12.0	A-4(8)	SiL	0	12	82	6	NP	NP	NP	NP
93	145+00	53Lt	7-8.0	A-4(8)	SiL	0	1	84	15	27	20	7	18
Boring Data along US41 from consultants' reports (16, 18, 19).													
94	453+00	30Lt	0.5-1.5	A-7-6(13)	Clay	0	3	48	49	41	19	22	13
95	448+00	30Lt	7-10.0	A-4(0)	SaL	0	61	35	4	NP	NP	NP	NP
96	435+00	35Rt	51-52.5	A-4(5)	Loam	4	42	40	14	21	16	5	12
97	432+50	50Rt	1.5-3	A-6(10)	SiClL	0	17	61	22	32	18	14	19
			3-5.0	A-6(11)	SiCl	0	5	56	39	38	21	17	24
98	432+00	70Lt	4-6.0	A-7-6(13)	Clay(Shaly)	0	0	47	53	47	27	20	24
99	430+00	60Rt	9-10.5	A-4(8)	SiClL	0	2	72	26	26	21	5	20
			16.5-18	A-6(12)	Clay	0	4	44	52	39	19	20	18
			20-21.5	A-7-6(19)	Clay(Shaly)	0	1	47	52	53	23	30	20
100	429+75	26Rt	5-6.0	A-7-6(17)	Clay	0	2	34	64	53	28	25	19
101	425+00	140Rt	60-61.5	A-4-(3)	SaL	0	50	41	9	NP	NP	NP	NP
102	423+00	26Lt	2-3.0	A-4(8)	SiL	15	19	54	12	30	20	10	18
			3-4.0	A-7-5(14)	Clay	14	17	38	31	50	31	19	26
103	422+00	26Lt	10-11.0	A-4(2)	SaL	0	60	28	12	NP	NP	NP	NP
104	417+25	26Rt	13-14.0	A-4(8)	SiL	0	26	64	10	NP	NP	NP	NP
105	415+20	85Rt	1-6.0	A-6(11)	SiClL	3	7	64	26	39	22	17	17
			6-10.0	A-7-6(13)	SiCl	1	4	51	44	44	23	21	15
106	392+70	26Rt	2-3.0	A-6(11)	ClL	1	32	43	24	38	20	18	24
107	377+20	26Lt	2-3.0	A-7-6(13)	Clay	1	11	43	45	44	23	21	15
			5-6.0	A-6(11)	SiClL	0	4	73	23	36	19	17	18

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
108	367+50	26Lt	2-3.0	A-7-6(13)	SiClL	0	18	53	29	45	24	21	18
109	362+70	26Lt	1-6.0	A-6(8)	SiCl	0	1	69	30	35	24	11	22
110	360+50	26Lt	5-6.0	A-4(4)	SaL	0	54	42	4	NP	NP	NP	NP
111	357+00	30Rt	1.5-4	A-6(11)	SiCl	0	4	60	36	35	24	11	22
112	339+00	34Rt"A"	7.5-9	A-4(8)	SiL	0	13	72	15	24	18	6	22
			.5-2.0	A-4(8)	SiClL	0	2	74	24	29	20	9	22
			2.5-4	A-6(11)	SiCl	0	4	62	34	38	20	18	18
113	322+75	32Rt"A"	.5-2.0	A-4(7)	Loam	0	32	48	20	21	16	5	16
114	303+00	32Lt"A"	.5-2.0	A-6(12)	SiClL	0	5	66	29	40	20	20	22
			4-6.0	A-4(2)	SaL	0	58	32	10	NP	NP	NP	NP
115	285+00	32LtPR-1	2-4.0	A-7-6(17)	Clay	0	1	41	58	49	21	28	19
116	270+50	32RtPR	1-2.0	A-4(8)	SiClL	0	3	75	22	29	19	10	23
117	260+00	32Rt	2-4.0	A-4(8)	SiClL	0	11	64	25	31	21	10	24
118	243+75	32Lt"A"	2-4.0	A-4(1)	SaL	0	61	28	11	NP	NP	NP	NP
119	241+00	32Rt"A"	.5-2.0	A-6(9)	Clay	1	15	46	38	35	22	13	23
120	218+00	37Rt"A"	.5-2.0	A-7-6(15)	Clay	0	4	44	52	49	26	23	21
121	215+75	37Rt"A"	6-8.0	A-6(9)	Clay	1	33	34	32	33	17	16	20
122	180+34	37Rt	2-3.0	A-7-5(17)	Clay	0	6	32	62	55	31	24	26
			13-14.0	A-7-6(11)	SiCl	0	0	58	42	42	26	16	22
123	178+50	37Rt	20-21.5	A-4(8)	SiClL	0	11	65	24	34	25	9	24
			27.5-29	A-3(0)	Sand	0	87	3	--	NP	NP	NP	NP
124	174+00	37Rt	10-12.0	A-6(10)	SiClL	0	4	68	28	38	22	16	16
125	168+00	--	13-14.0	A-6(9)	SiCl	0	10	55	35	34	21	13	19
126	165+00	--	14-15.0	A-4(1)	SaL	0	61	30	9	NP	NP	NP	NP
127	163+00	--	.3-0.6	A-7-6(12)	SiCl	0	3	52	45	42	24	18	20
			7-8.0	A-4(8)	SiClL	0	27	50	23	29	20	9	19

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
128	157+00	--	4-5.0	A-7-5(15)	SiCl	0	4	50	46	52	30	22	20
129	154+00	--	13-14.5	A-4(3)	SaL	0	50	39	11	NP	NP	NP	NP
130	152+00	--	9-10.0	A-6(10)	SiCl	0	4	62	34	39	23	16	18
			17-18.0	A-4(6)	Loam	0	35	47	18	19	13	6	19
131	146+00	--	1-6.0	A-6(10)	SiCl	0	6	54	40	38	22	16	19
132	140+00	10Rt	2-3.0	A-6(10)	SiCl	0	4	56	40	39	24	15	19

APPENDIX C

SOIL CLASSIFICATION AND PROFILE SYMBOLS

Description	Grain Size Distribution				Plastic Index	Symbol
	Gravel % Retained on #10	Sand #10–#200	Silt 0.05–0.005mm	Clay Less than 0.005mm		
Gravel	85–100	0–15	0–10	0–10	NP	
Sandy Gravel	50–85	15–50	0–10	0–10	6 Max.	
Sand	0–15	85–100	0–10	0–10	NP	
Gravelly Sand	20–49	45–85	0–10	0–10	6 Max.	
Sandy Loam	0–19	50–80	0–50	0–20	6 Max.	
Sandy Clay Loam	0–19	50–80	0–30	20–30	10 Max.	
Sandy Clay	0–19	55–70	0–15	30–45	11 Min.	
Loam	0–19	30–50	30–50	0–20	10 Max.	
Silt Loam	0–19	0–50	50–100	0–20	10 Max.	
Silty Clay Loam	0–19	0–30	70–100	20–30	11 Min.	
Silty Clay	0–19	0–15	55–70	30–45	11 Min.	
Clay Loam	0–19	20–50	50–80	20–30	11 Min.	
Clay	0–19	0–55	0–55	30–100	11 Min.	
Peat or Muck						
Limestone						
Sandstone						
Shale						
Stony Fragments						
Organic Matter						
Topsoil						

Classification of Gravelly Soils

85%–100% gravel plus finer material – Gravel
50%–84% gravel plus finer material – Clayey, silty or sandy gravel
20%–49% gravel plus finer material – Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%–19% gravel plus finer material – Use fine classification only

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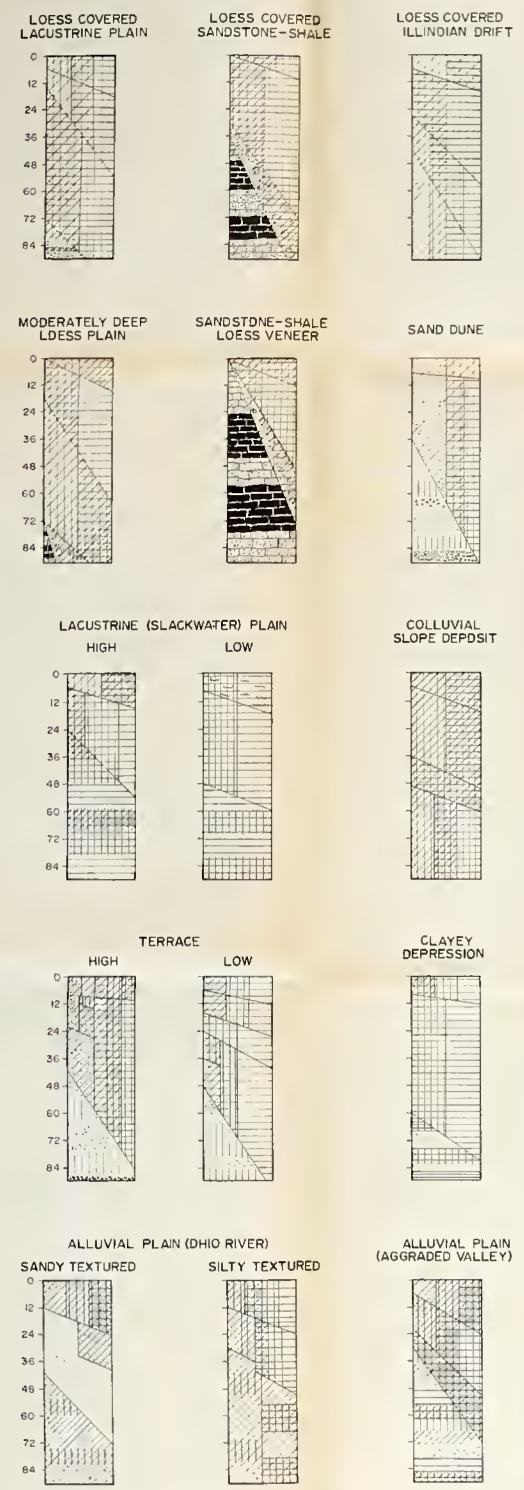
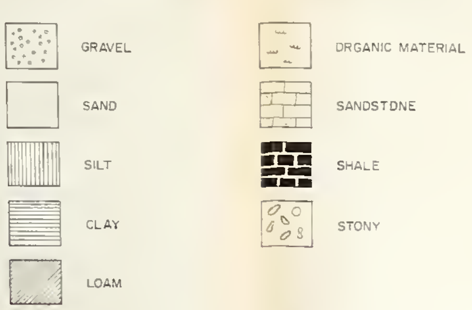
GENERAL SOIL PROFILES



TEXTURAL SYMBOLS FOR SOIL PROFILES



PREPARED UNDER THE SUPERVISION OF: P T YEH

POLYCONIC PROJECTION

LEGEND

PARENT MATERIALS
(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- MODERATELY DEEP LOESS PLAIN
- LOESS COVERED LACUSTRINE PLAIN
- LOESS COVERED SANDSTONE-SHALE
- LOESS COVERED ILLINOIAN DRIFT
- INTERBEDDED SANDSTONE-SHALE WITH LOESS VENEER
- TERRACE
- LACUSTRINE PLAIN
- ALLUVIAL PLAIN
- SAND DUNE
- COLLUVIAL PLAIN
- CLAYEY DEPRESSION

MISCELLANEOUS

- BORING SITE
- LAKE OR POND
- BORROW PIT

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

ENGINEERING SOILS MAP
VANDERBURG COUNTY
INDIANA

PREPARED FROM

1940 AAA AERIAL PHOTOGRAPHS

BY

JOINT HIGHWAY RESEARCH PROJECT

AT

PURDUE UNIVERSITY

1975

SCALE OF MILES

CONIC PROJECTION

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